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LLNL-CONF-646165

Progress report:: NTOF-extracted C rhoR for gas symcap shots

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Disclaimer

Measuring Ablator Areal Density using Neutron Time-of-Flight at the National Ignition Facility

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Lawrence Livermore National Laboratory • National Ignition Facility & Photon Science

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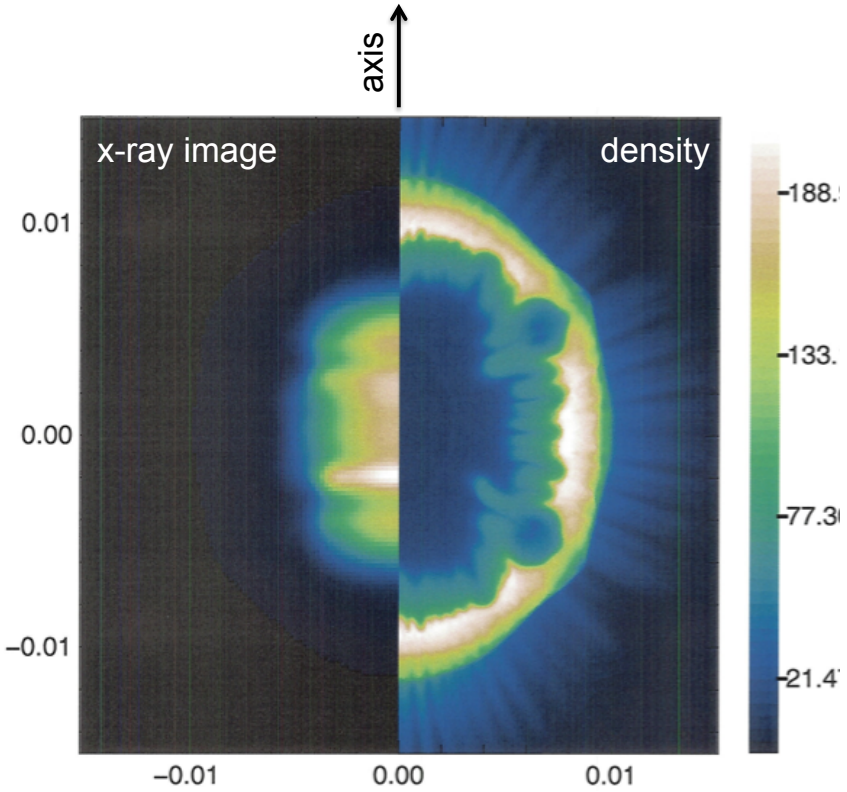
Outline

- Motivation
- Features in spectrum
- Fits to data
- Comparison to other carbon rho.R measurements and simulations
- Conclude

The motivation is to measure how much carbon (ablator) is left and to compare to simulations and other measurements

- Initially motivated by seeing what features we could extract from the neutron spectrum as measured by NIF NTOF detectors
- The remaining mass of CH ablator is much larger than in simulations - ~15% range vs. a few percent in simulations
  - Energy not being coupled into ablator as expected
- Measuring this quantity with the NTOF gives a LOS-dependent determination to compare to
  - GRH which is 4pi averaged
  - Ross Pair filters which have different directionality

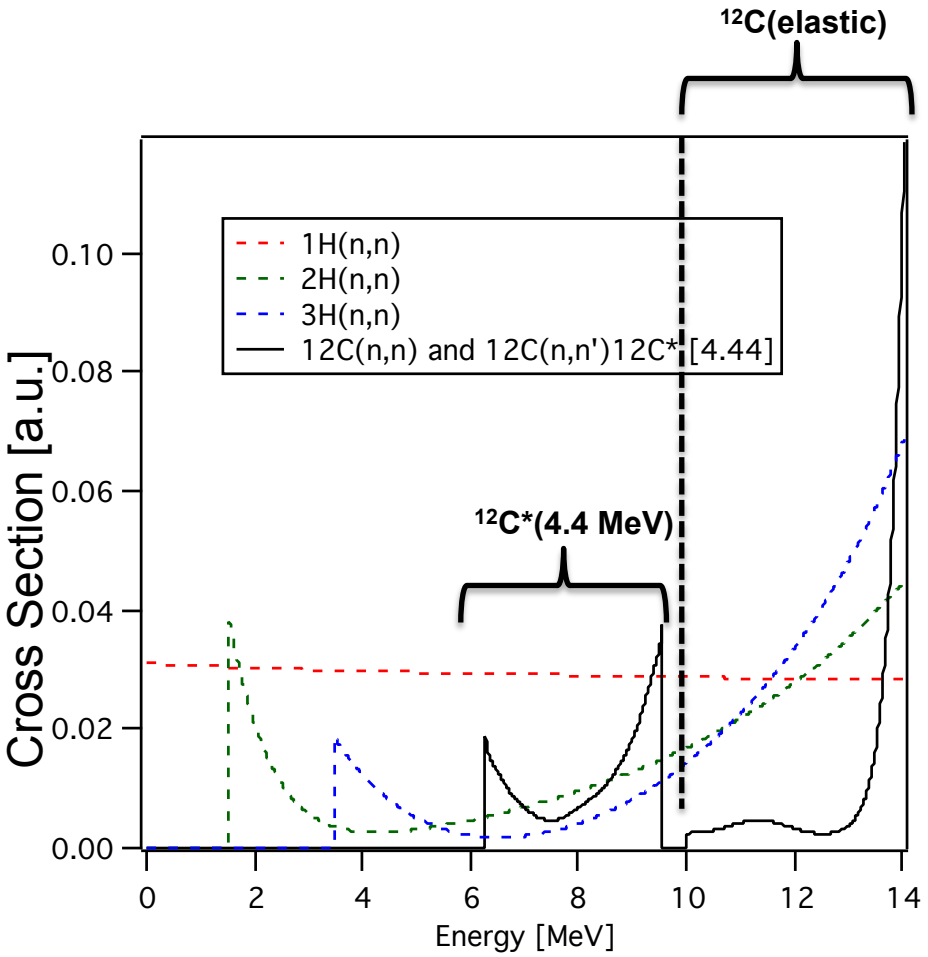


2D Symcap simulation (B. Spears) shows shell structure

Methodology: Fitting carbon-specific features in the neutron spectrum determine the carbon rho.R

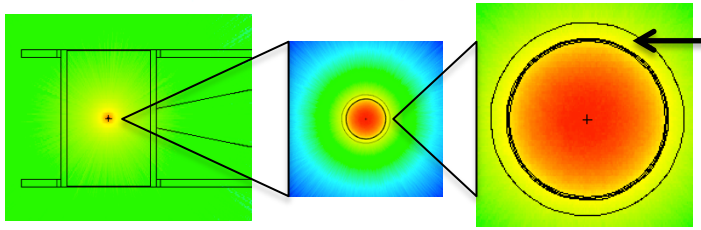
- Two approaches:
  - Fit single scatter cross sections
    - Not preferred because of multiple scattering from higher rho.R shots
  - Fit simulations to data
    - Preferred because simulations include
      - Multiple scattering

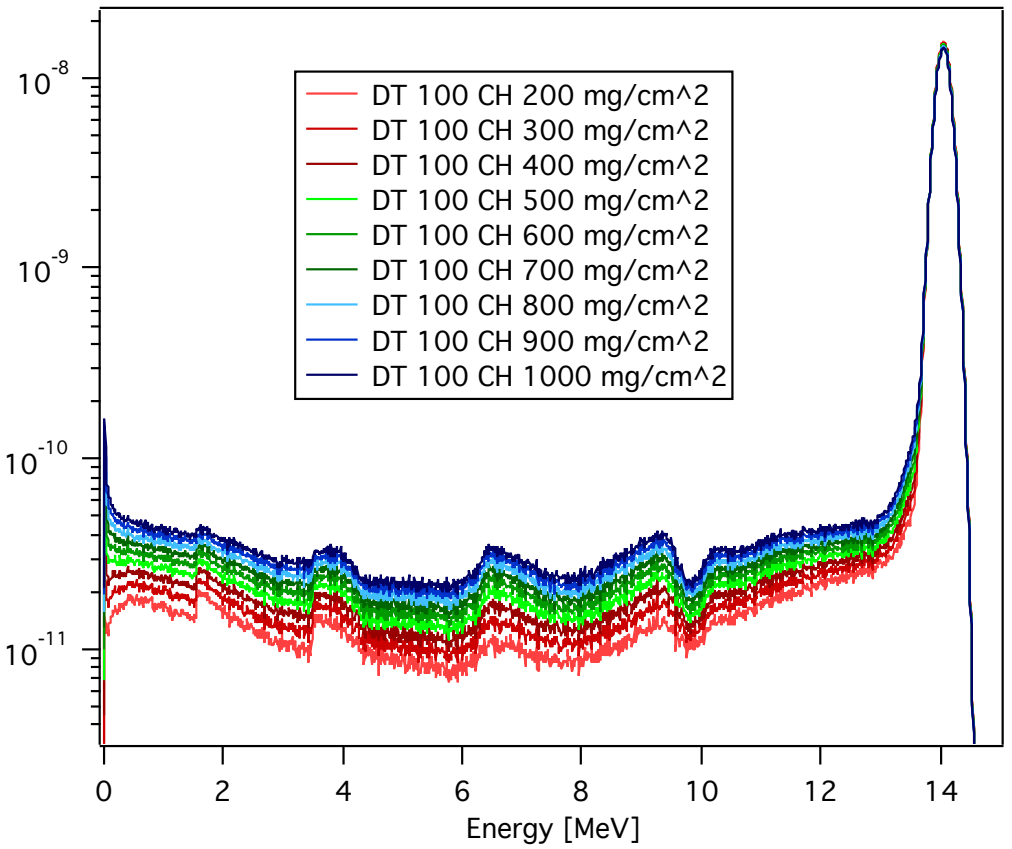
- General procedure:
  - Try to fit the data in a region of interest (the $^{12}C^*$[4.44 MeV] edge), with several simulated spectra assuming golf ball geometry
  - Minimize chi-square parameter in ROI
  - Report CH rho.R
  - Convert to C rho.R by ASSUMING C:H 1:1.38



Methodology: A simple MCNP (neutron transport) model is used to determine spectra to fit to data

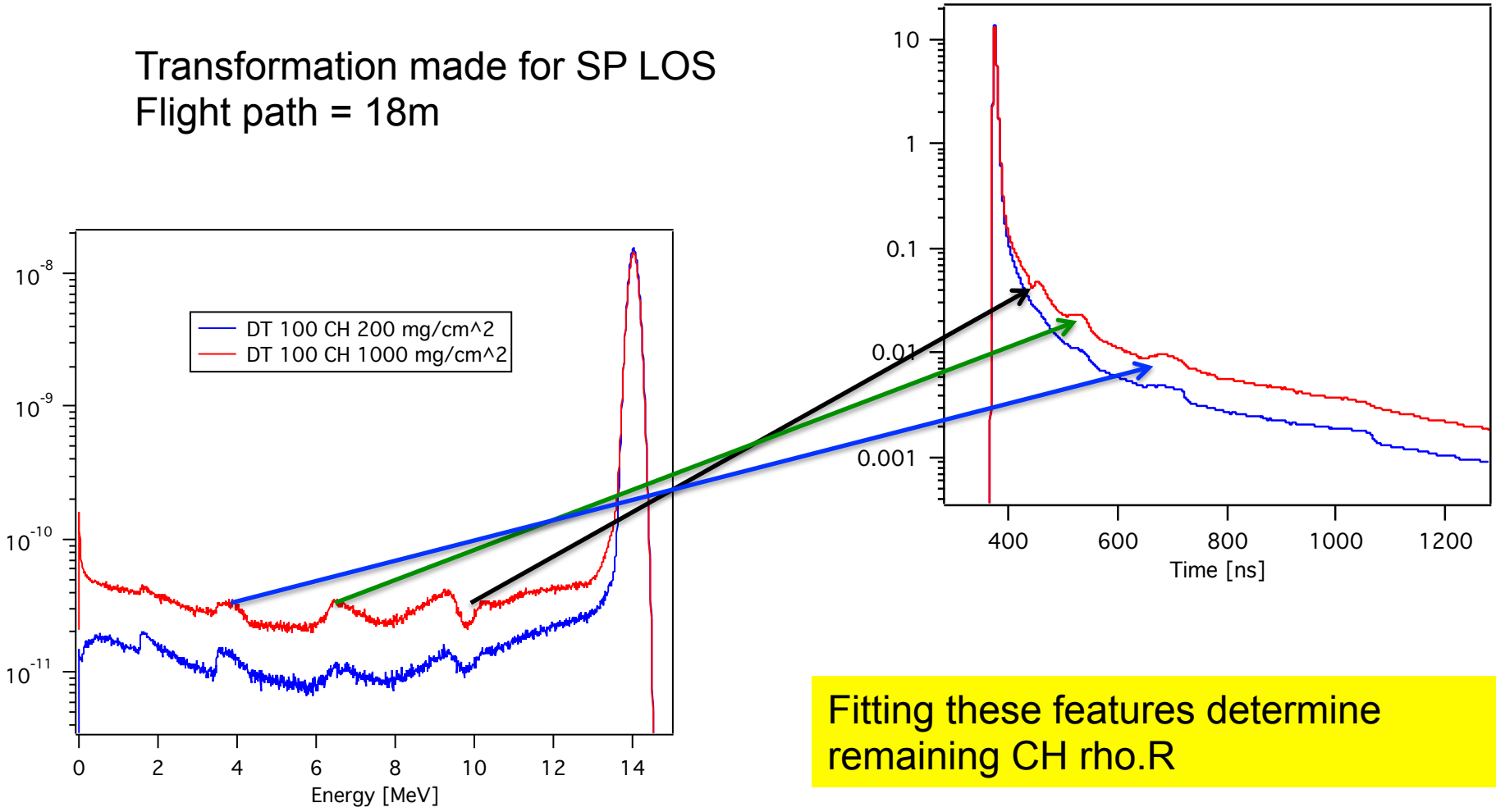
- **MCNP model:**
  - **Spherical onion model**
  - **P0 50 um (25 for cryo)**
  - **Dense ablator 50-60um**
  - **DT rho.R 100 mg/cm^2**
    - **(given amount of gas and shell volume(from sims) this is about right)**
  - **Inside hohlraum and TMP**
  - **Temperature = 2.7 keV**
    - **To match N130505**
  - **E0 = E0(Tion) (Ballabio)**
- **Transform through IRF (sensitivity corrected) and fit to the data**





How do these features in energy map to features in neutron Time of Flight?

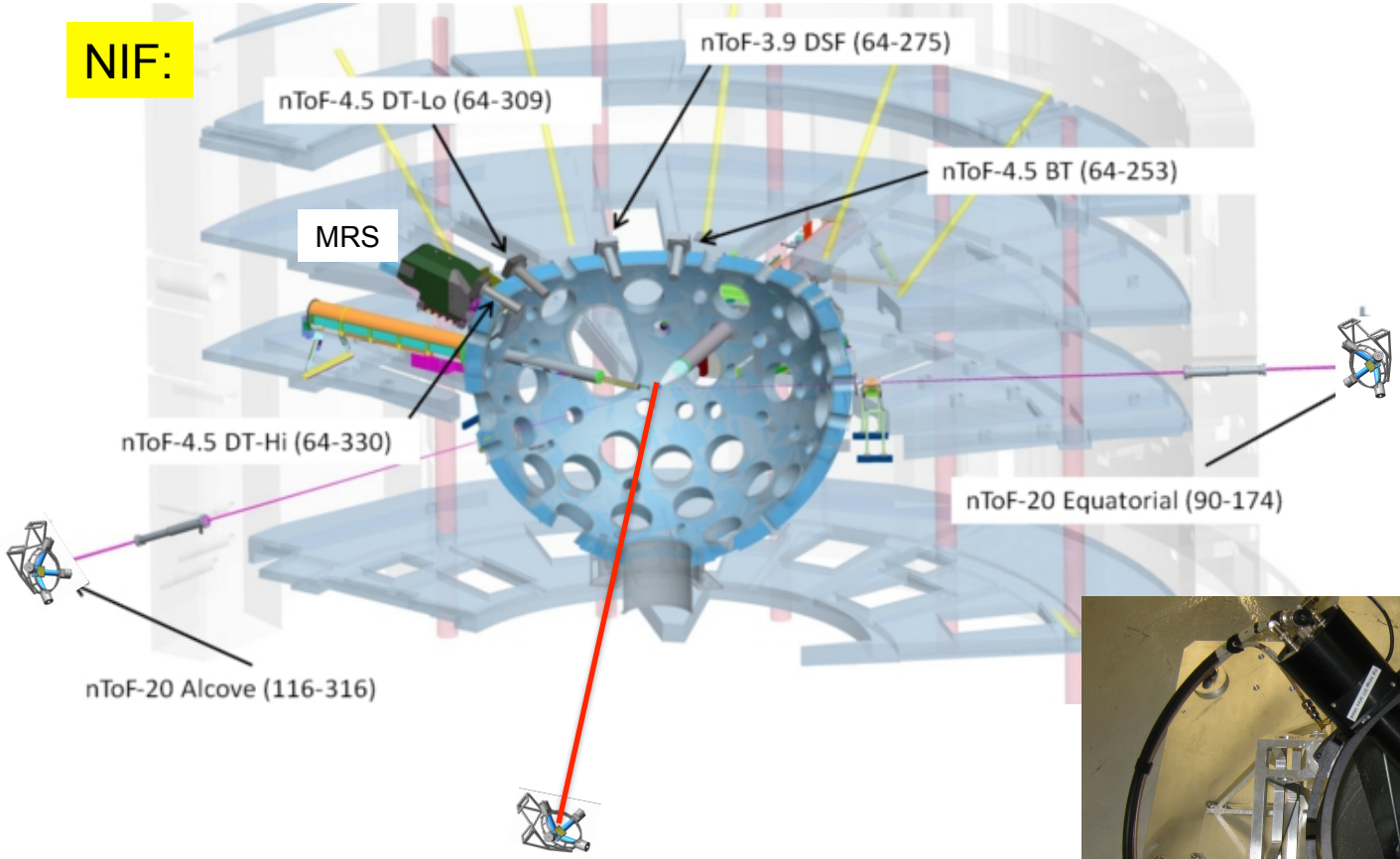
Transformation made for SP LOS
Flight path = 18m



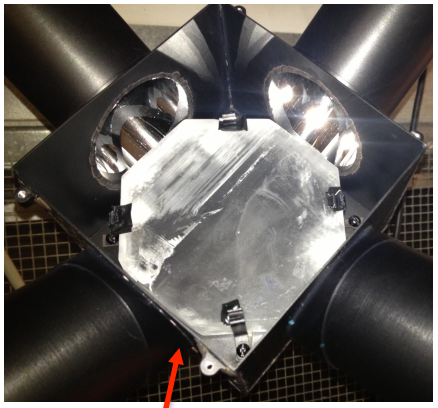
Fitting these features determine remaining CH rho.R

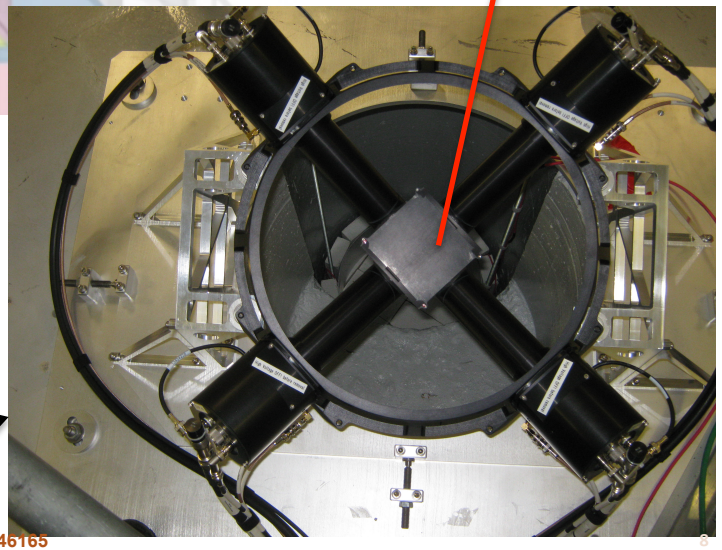
NTOF diagnostics and NIF Symcap Data

Neutron Time-Of-Flight detectors at NIF measure several implosion variables on many different LOS



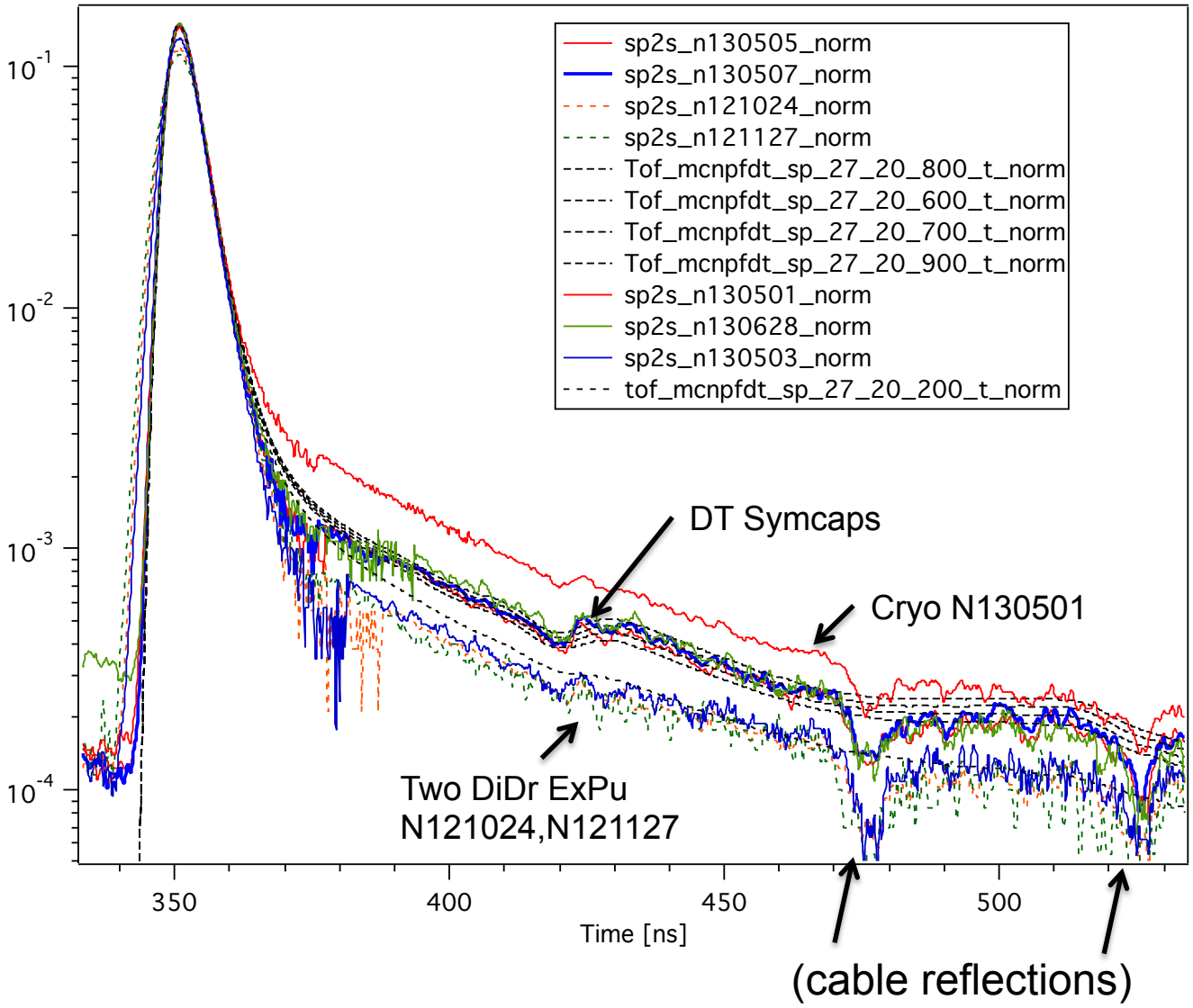
Bibenzyl,0.5% Stilbene





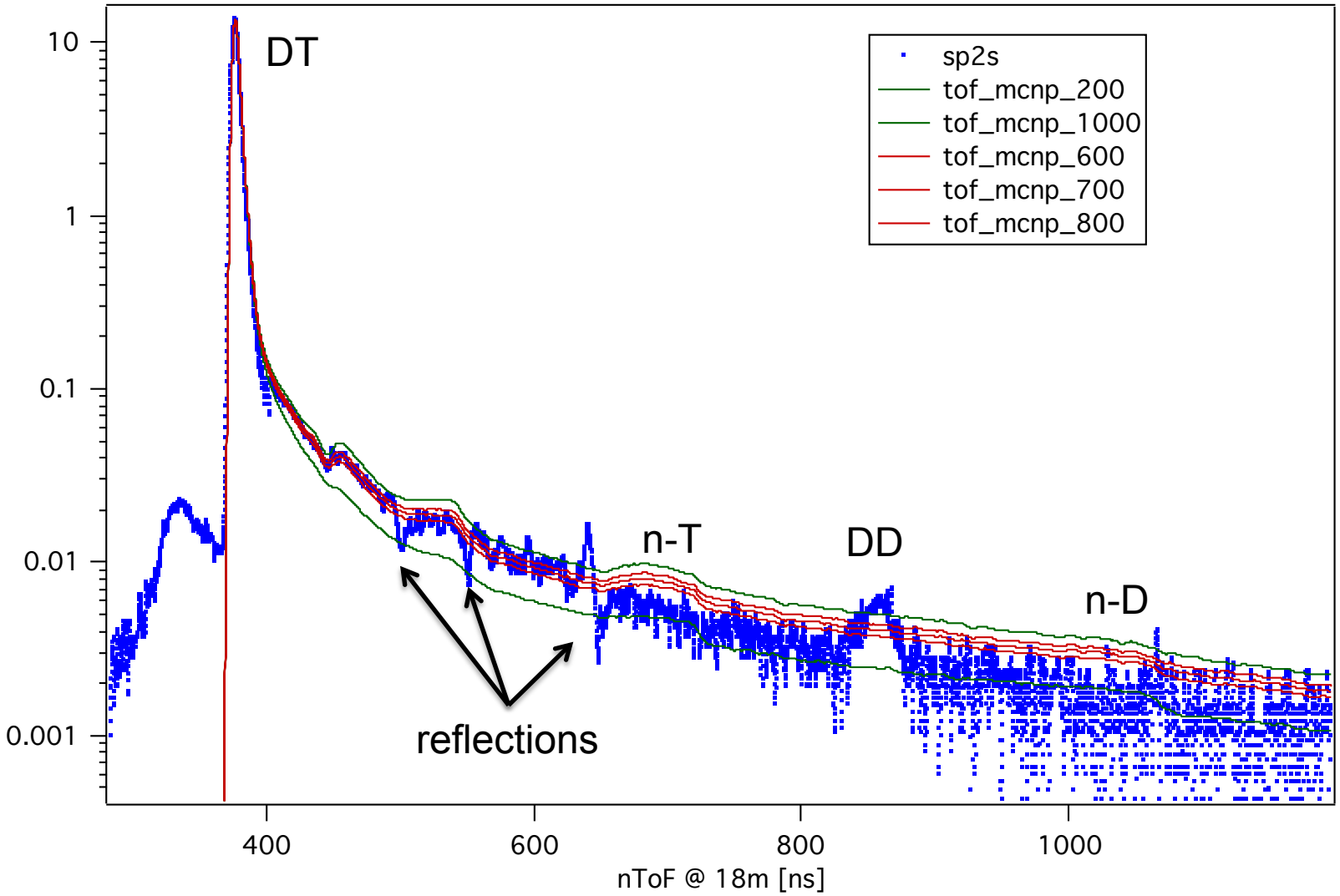
New spectral JacBlac/ Bibenzyl detectors fielded on the NIF are providing excellent ntof data

Different classes of shots show measureable levels of CH ablator remaining



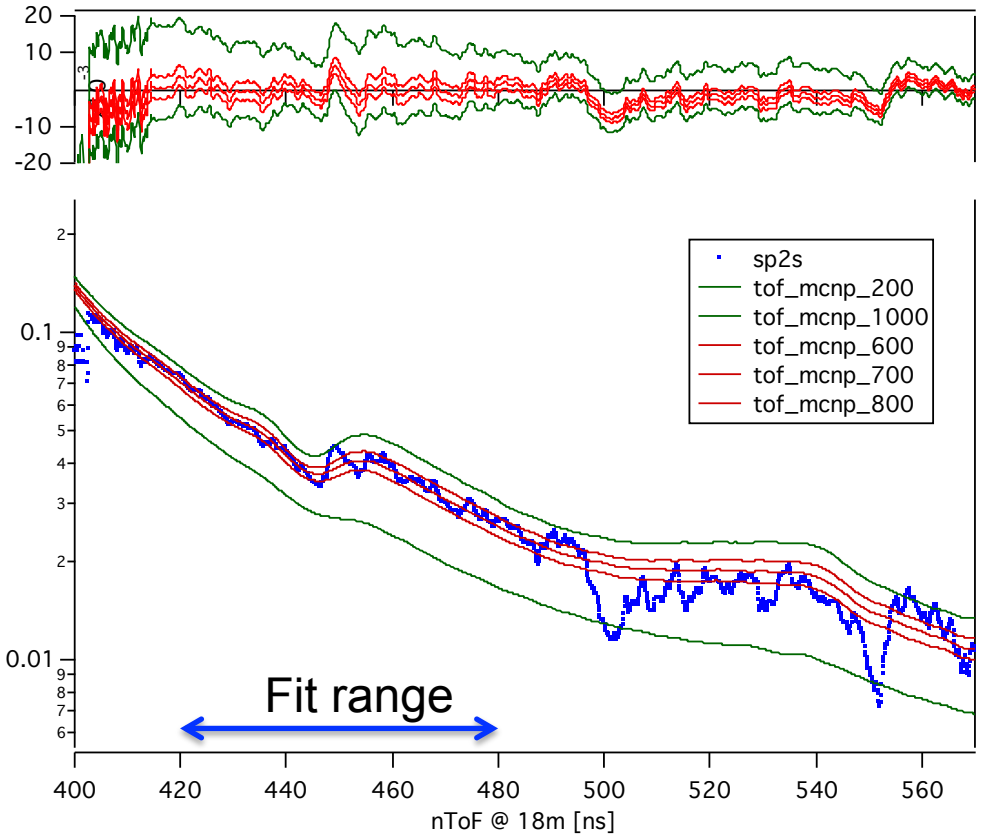
N130505-001-999

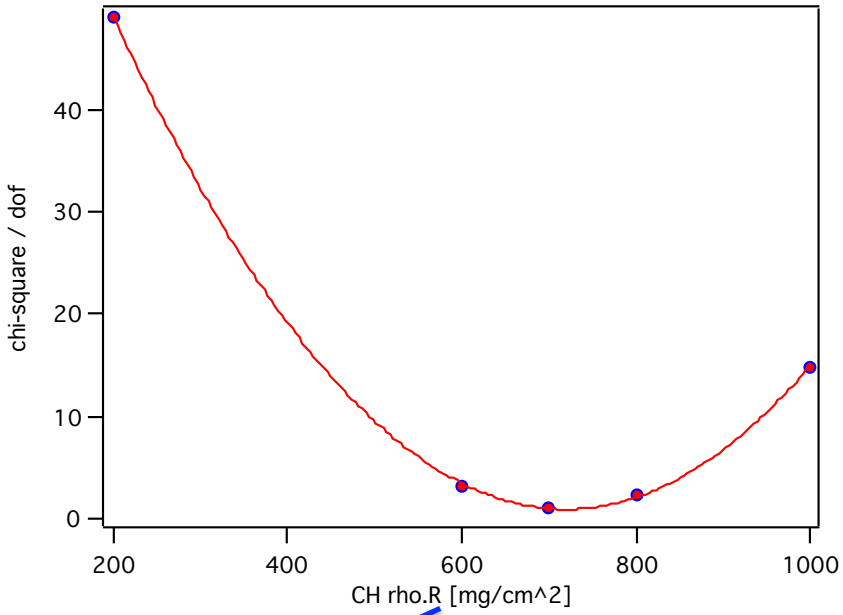
Simulations overlaid on data show a clear sensitivity to the carbon features



N130505-001-999

Method 1: Fitting the simulations to a small ROI produce a good measure of the CH ablator areal density

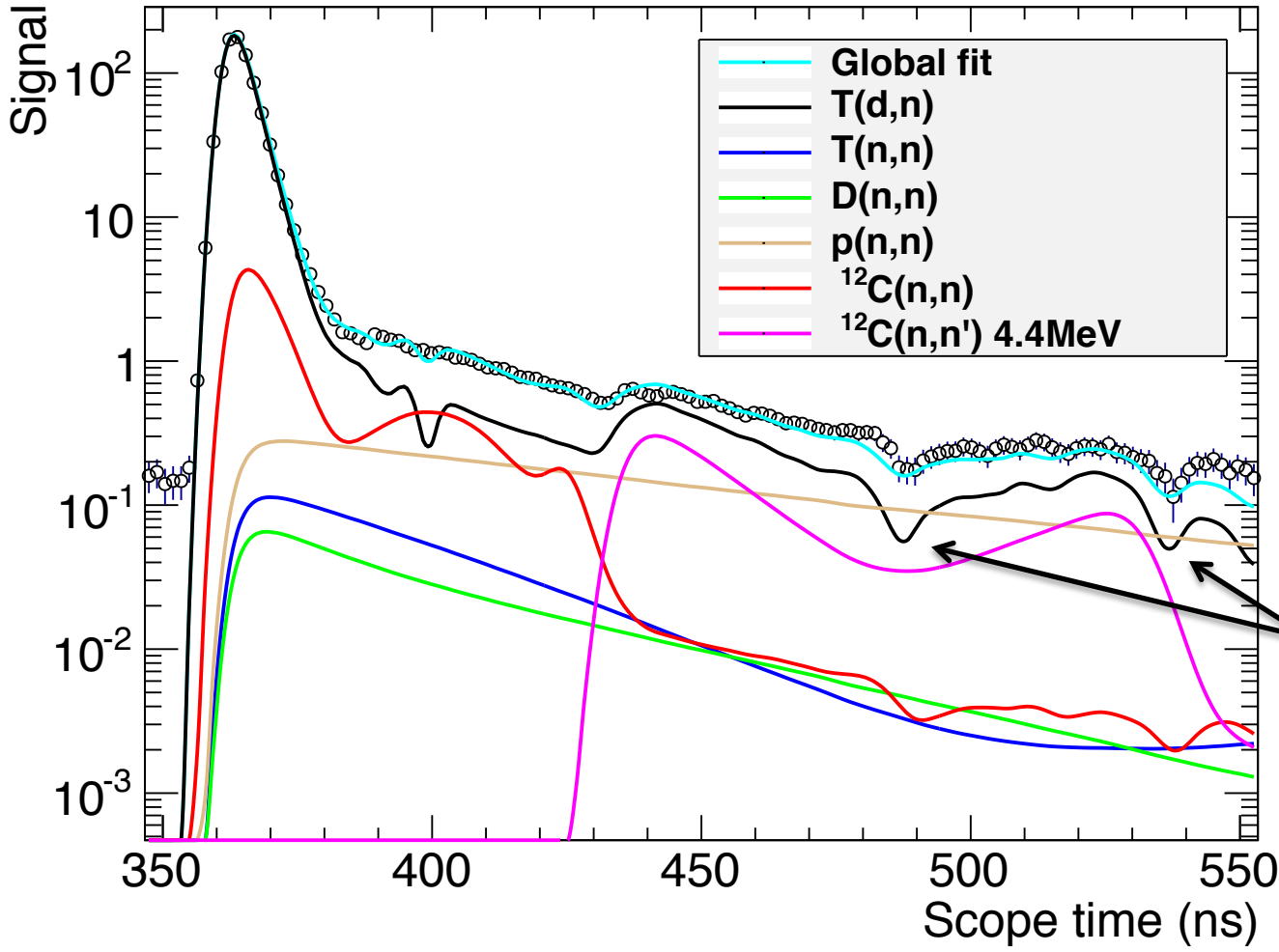




CH rho.R inferred from NTOF SpecSP is 718±71 mg/cm^2

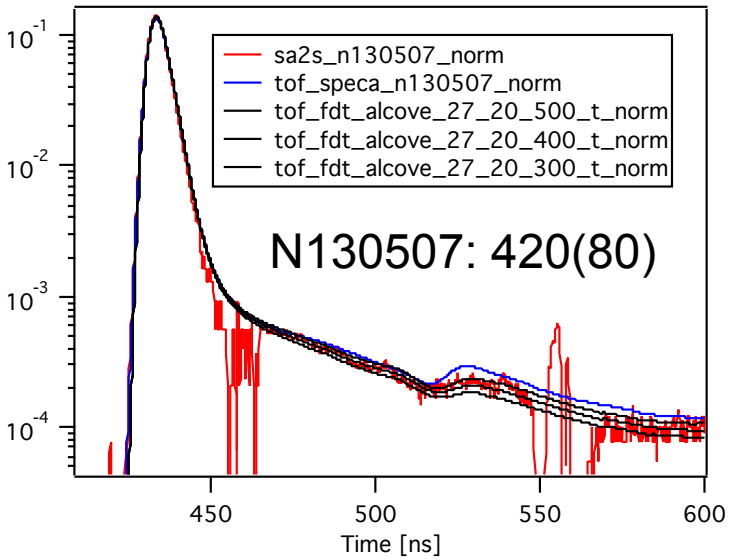
N130507-001-999

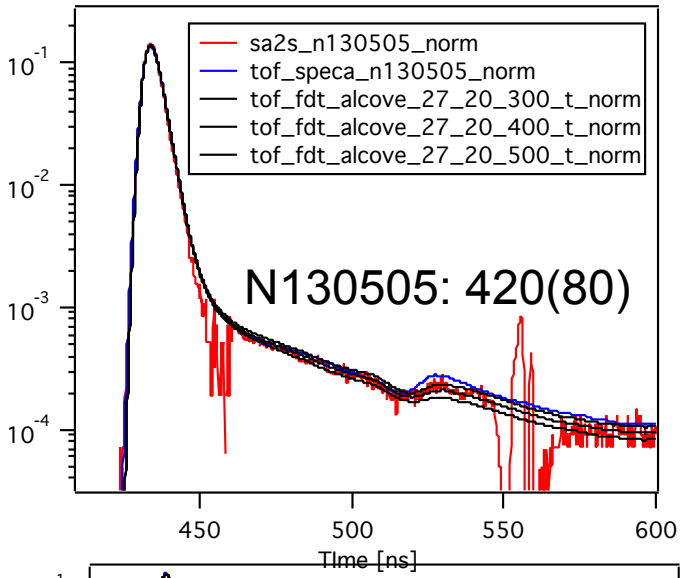
Method 2: Using the single scattering cross sections to fit the data produce similar fits and results

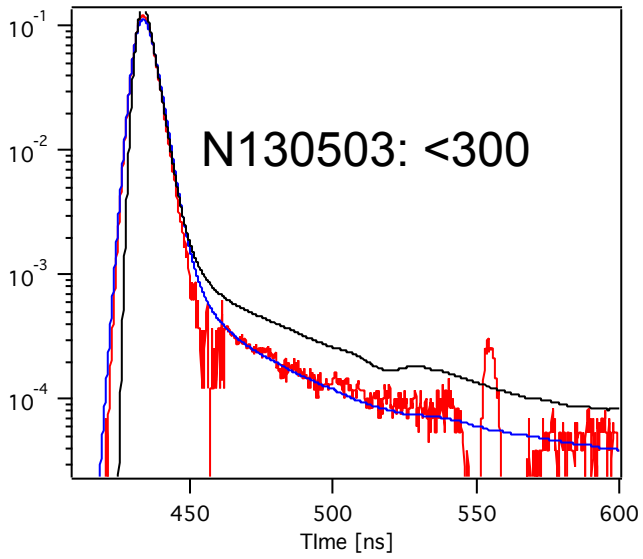


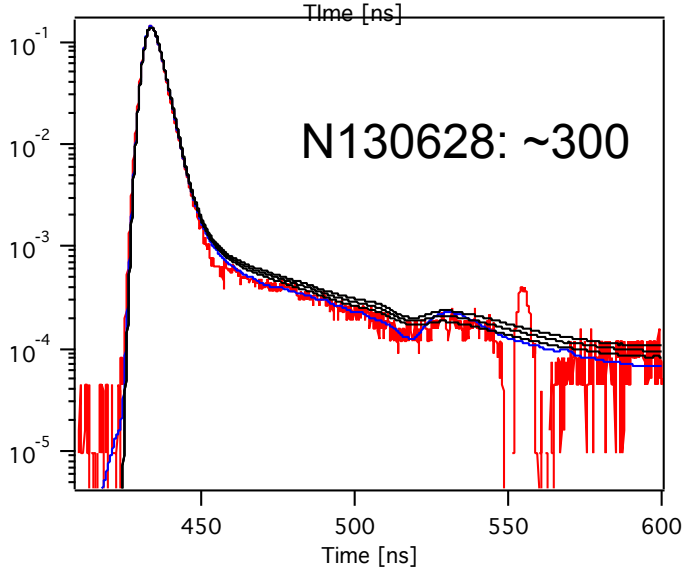
(updated IRF includes reflections)

Other LOS (alcove) data shows lower CH rho.R than the south pole on all shots









Carbon ρR results are larger on the south pole but average agrees with other diagnostics and simulations

Carbon ρR	SpecSP ±~10%sys	SpecA	SpecE	LOS avg	GRH	Simulations
N130503*	<200	<300	<300			--
N130505	660±70	380(50)	450(300)	497(~100)	520(120)	485
N130507	670±70	380(50)	450(300)	500(~100)	580(120)	495
N130625	500±60	300(50)	450(300)	417(~100)		--
N130628	760±80	270(100)	450(300)	493(~100)	~600	--

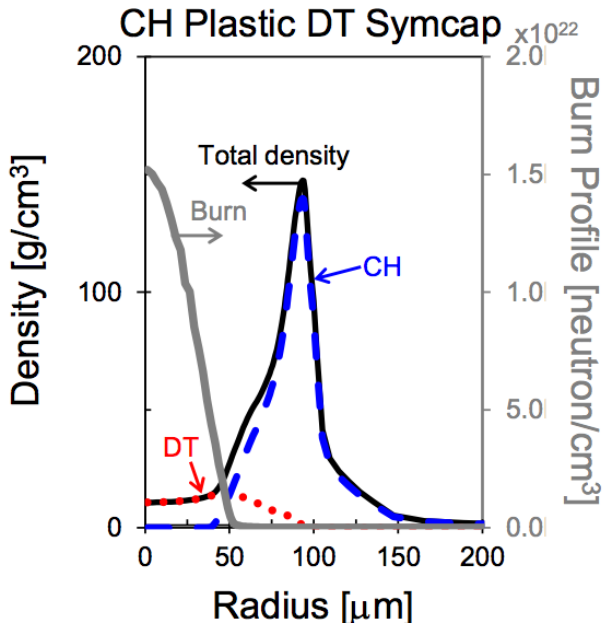
DSR, defined as N(10-12)/N(13-15) is consistent with this picture

DSR	SpecSP	SpecA	SpecE	Simulations
N130503	0.2(2)	0.2(1)	0.45(30)	0.010 / 0.096 / 0.096
N130505	1.5(3)	1.0(3)	1.1(4)	1.04 / 1.01 / 1.00
N130507	1.3(3)	1.1(3)	1.3(4)	1.15 / 1.12 / 1.12
N130625	1.5(3)	0.8(3)	1.1(3)	--
N130628	1.45(30)	0.7(3)	0.7(3)	0.69 / 0.68 / 0.69

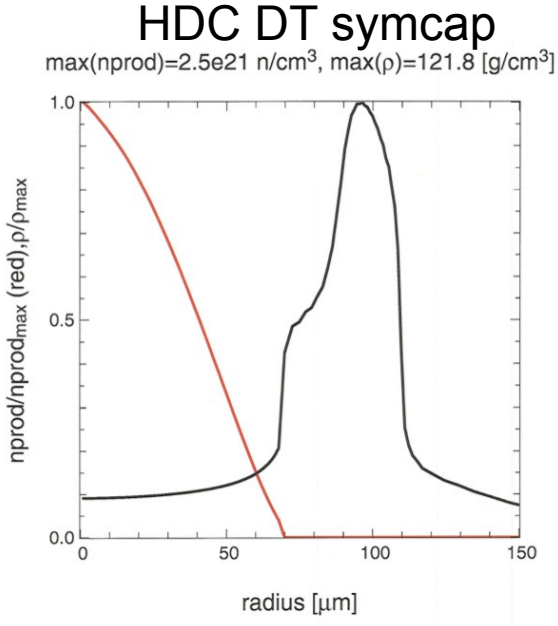
Summary and Future plans

- **Carbon rho.R's extracted are in good agreement with GRH**
  - **Systematic errors of geometry and DT rho.R up to 20%**

- **Next implement better burn profiles, including a mixed DT/CH region:**



D. Casey, S.Weber

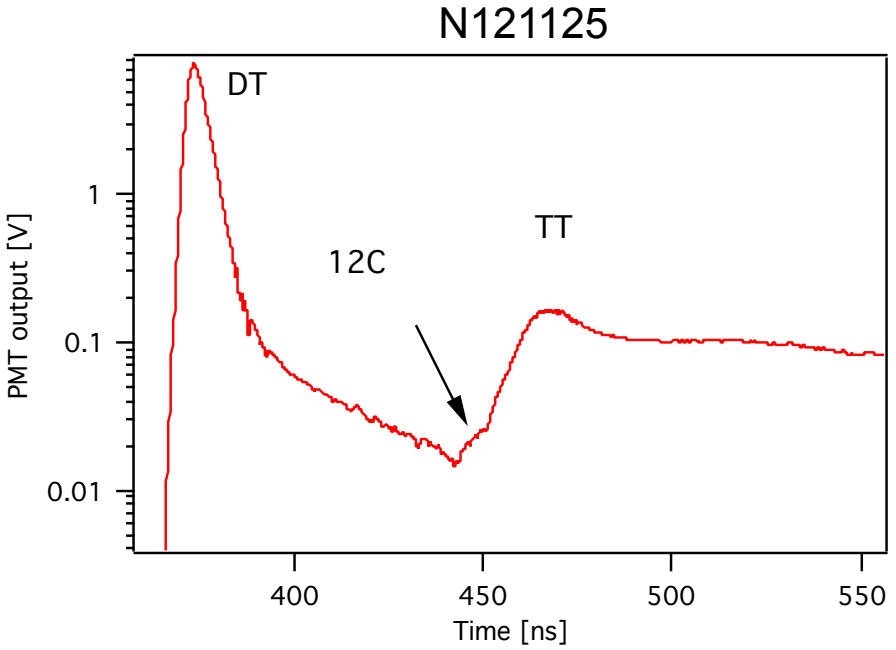


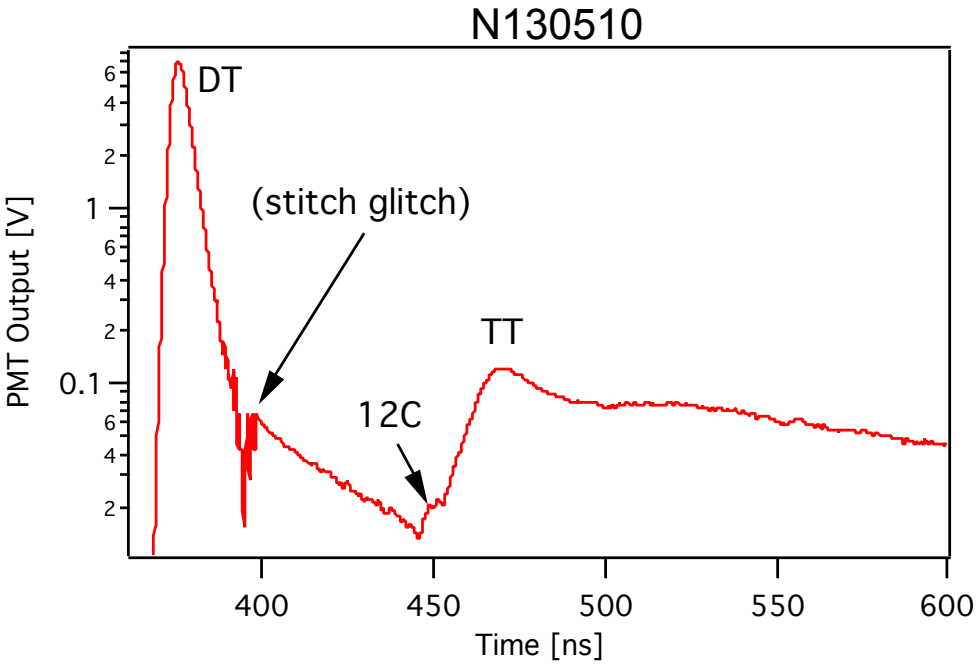
B. Spears, S.Weber


NIF

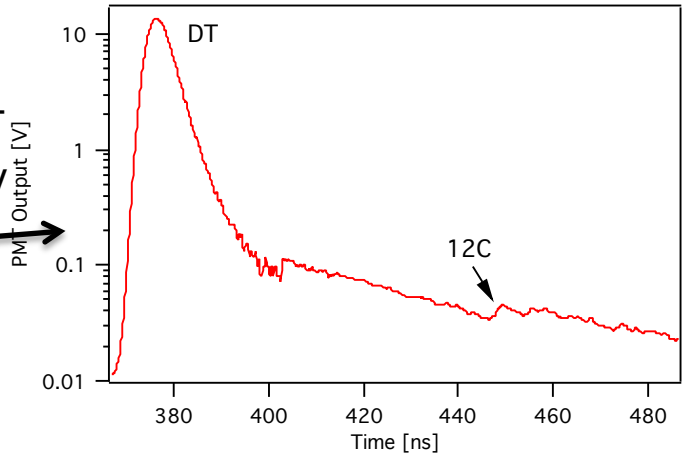
Backup slides

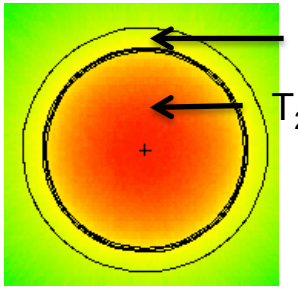
Carbon $^{12}C(n,n')^{12}C^*[4.44MeV]$ feature observed in N121125 and N130510





Compare with N130505 DT symcap where there is very little TT
(CH rho.R = 720 mg/cm^2 (10%stat,20%sys)





CH with thin CD layer

T_2, 0.1%D2 100 mg/cm^2